Chapter 6
Surveyor Data Collector Interface and Formats

For many surveying operations, electronic data collection is routine. However, once the data are collected, most software systems require a large amount of post-processing to produce a map showing planimetrics and contours.

6-1. Computer Interfacing

Many of the benefits of automated data collection are lost if the data stored cannot be automatically transferred to a computer system. The information is down-loaded from the data collector to the computer. The file is usually an American Standard Code for Information Interface (ASCII) file. The measured distances, angles, or elevations entered into the data collector are output, but the format is not easily read. This is because the data are contiguous; nothing separates one piece of data from another. Every data collector stores data in a different format and the problem is to translate the data from the data collector format into a file with a standard ASCII format. Data standardization will become more important in the future, and surveyors should be searching for methods which make system integration easier.

6-2. Data Standardization

Data standardization is becoming more important as the concerns of redundant data and lack of shared data rise. Such standardization will reduce the cost of preparing the raw survey data for submission.

6-3. Coordinate File Coding

This section describes a coding scheme that can adequately define the survey parameters. These code records would be inserted into the ASCII coordinate file produced by the data collector. The codes are developed for general USACE topo survey requirements for A-E applications. Additional codes may need to be developed to suit particular applications. All code records will begin with a "#" in column 1, and are limited to 80 columns. All comment records will begin with a ";" in column 1, and are also limited to 80 columns.

a. Survey job parameters. Header records are required to describe the survey job parameters such as *Horizontal Datum, Units of Measure, Survey Date, Job Location, Survey Firm, etc.* H20 to H29 are reserved for job title. H30 to H99 are reserved for any comments about the survey job. If sketches or survey data were recorded in survey field books, the book and page numbers shall be indicated on the H12 and H13 records. This allows for an easy reference to original field data.

(H-RECORDS)
#H01 - ASCII FILE NAME
#H02 - SURVEY DATE
#H03 - SURVEY ORDER
#H04 - HORZ DATUM
#H05 - JOB NUMBER
#H06 - UNITS OF MEASURE
#H07 - MAP PROJECTION
#H08 - LOCATION
#H09 - AE CONTRACTOR
#H10 - BOOK NUMBER
#H11 - PAGE NUMBER
#H12 - COMBINED SCALE FACTOR
#H20 - JOB TITLE
#H21 - TITLE CONTINUATION
#H29 - TITLE CONTINUATION
#H30 - COMMENTS
#H31 - COMMENTS CONTINUATION
#H99 - COMMENTS CONTINUATION

b. Horizontal/vertical control. All control points whether found or established must be described by control code records. Vertical control records are required to define the parameters such as *Vertical Datum, Benchmark Name, Epoch, etc.,* used to determine the survey point elevations. These records are required at the beginning of a file and where the vertical parameters change.

(V-RECORDS)
#V01 - VERTICAL BENCHMARK
#V02 - GIVEN BM ELEVATION
#V03 - EPOCH (YR OF ADJUSTMENT)
#V04 - VERTICAL DATUM
#V05 - CONDITION OF MARK
#V06 - ELEVATION FOUND
#V10 - ANY COMMENTS THAT THE
#V11 - SURVEYOR MAY WANT TO MAKE
#V12 - ABOUT THE BENCHMARK OR
#V99 - LEVEL RUN.

c. Baseline parameters. These records describe the reference baseline. If a baseline listing is available on diskette the user may include the file name on the B00 record. Each baseline PI is defined by its coordinates and station number. Curve data are defined by BC, BI, and BT records. These records define the coordinates, and

station number of the *Point of Curve, Point of Intersection, and Point of Tangent.*

(B-RECORDS)
#B01 X-crd Y-crd STATION
#B02 X-crd Y-crd STATION
#B99 X-crd Y-crd STATION

BASELINE FILE NAME
#B00 FILE.EXT

CURVE PARAMETERS
#BC1 X-crd Y-crd STA (PC)
#BI1 X-crd Y-crd STA (PI)
#BT1 X-crd Y-crd STA (PT)

d. Temporary benchmarks (TBM). All TBM used whether established or found must be defined with TBM records. The PBM used to set the TBM will be assumed to be the previous V01 record (V-Records). The date set will come from the last "H02" record. T10 through T99 are used for description of mark.

(T-RECORDS)
#T01 TBM NAME
#T02 GIVEN ELEVATION
#T05 CONDITION OF MARK
#T06 ELEVATION FOUND
#T10 DESCRIPTION
#T11 DESCRIPTION CONTINUED
#T99 DESCRIPTION CONTINUED

e. Water surface elevation. Gauge records are required each time a gauge is read.

(G-RECORDS)
#G01 STAFF GAUGE CODE#
#G02 GAUGE NAME
#G03 GAUGE READING
#G04 TIME OF READING
#G10 DESCRIPTIONS AND OR
#G11 COMMENTS ARE INCLUDED
#G12 FROM G10 TO G99

f. Cross-section parameters. Each cross-section must be preceded by an X01 record. If the section contains sounding data controlled by a gauge, an X03 (time) and X04 (elevation) record must be included showing the interpolated water surface elevation.

(X-RECORDS)
#X01 BX BY EX EY STATION NAME
#X02 Range Code
#X03 TIME OF SECTION (IF SNG)
#X04 WATER SURFACE ELEVATION

g. Profile parameters. Each reach of profile must be preceded by a P01 record. If the profile contains sounding data controlled by a gauge, a P03 (time) and P04 (elevation) record must be included showing the interpolated water surface elevation.

(P-RECORDS)
#P01 BX BY STATION
#P03 TIME OF PROFILE (IF SNG)
#P04 WATER SURFACE ELEVATION
#P10 TITLE OF PROFILE

h. Miscellaneous records. These records are required on miscellaneous shots. The record will contain a general description of the points that follow.

(M-RECORDS)
#M01 Borehole locations at the south end of the ammo
#M02 plant located in the U.S. Army Reserve Complex
#M03 in Corn Bayou, La., near the WABPL.

6-4. Data Sets

A data set is defined as a cross section, a profile, or a group of topo shots. A data set begins and ends with the M, P, or X code records. For example a profile data set begins with the P records and is terminated by any M, P, or X record.

INDEX OF CODE RECORDS

#B01 - Coordinates and station of baseline PI.

#B00 - Name of ASCII coordinate file that contains the survey data.

#BC1 - Coordinates and station of point of curve for curve #1.

#BT1 - Coordinates and station of point of tangent for curve #1.

#BI2 - Coordinates of point of intersection for curve #2.

#C01 - Party Chief.

#C02 - Instrument Man.

#C03 - Rodman.

#G01 - Staff gauge code number supplied by USCOE.

#G02 - Name of gauge.

#G03 - Water surface elevation as read on gauge.

#G04 - Time (1423) of gauge reading based on 24-hr clock.

#G10-G99 - Descriptions and or comments are limited to 75 characters per record.

#H01 - Standard DOS file name of ASCII file which contains the survey data. More than one file is allowed per survey job.

#H02 - Date (DD/MM/YY) on which the following information was obtained.

#H03 - Order (accuracy) of survey. (1,2,3..AA).

#H04 - Horizontal datum on which the survey is referenced. (NAD-1927, NAD-1983, WGS-84,...).

#H05 - Job number of survey. (YY-JJJ).

#H06 - Unit of linear measure (FT, MT, MI, ...).

#H07 - Map projection. Use standard list of projection codes (1702, 1703, ...).

#H08 - Location of survey such as nearest town, river, channel, basin. More than one location is allowed per survey.

#H09 - Survey firm or organization.

#H10 - Index number of survey field book in which the following information is recorded.

#H11 - Page number of field book specified by previous H10 code on which the following information is recorded.

#H12 - Combined scale factor.

#H20 - Title of survey job. The survey title is limited to 75 characters per record.

#H21-H29 - Continuation of survey job title.

#H30 - Reserved for any comments about the survey job. The comments are limited to 75 characters per record.

#H31-H99 - Continuation of comments about the survey job.

#I01 - Instrument.

#I02 - Serial number.

#M01-M99 - Description of miscellaneous survey points that follow.

#P01 - The profile segment's beginning x-y coordinates and stationing.

#P03 - Time of profile. Only needed if elevations of points are relative to prorated water surface.

#P04 - Prorated water surface elevation used for elevation of points in profile.

#T01 - Name of temporary benchmark (TBM).

#T02 - Given elevation of TBM.

#T05 - Condition of TBM.

#T06 - Found elevation of TBM.

#T10-T99 - Description of TBM.

#X01 - The range line definition which contains the end point coordinates, station, and name of the range.

#X02 - Range code or index number.

#X03 - Time of cross-section. Only needed if elevations of points are relative to prorated water surface.

#X04 - Prorated water surface elevation used for elevation of points in cross-section.

#W01 - Temperature.

#W02 - Pressure.

#W03 - Humidity.

#W04 - Cloud conditions
(0-10%: clear
10-50%: scattered
50-90%: broken
90-100%: obscured)

#W05 - Wind speed.

#W06 - Wind direction
(N,S,E,W,NE,NW,SE,SW)

6-5. Computer-Aided Design and Drafting (CADD) Interface

CADD software packages are commonly available that can produce basic survey plots to finished map sheets. Such drafting tools offer the surveyor more accuracy, efficiency, flexibility, and quality in the production of hard copy plots. Microstation™, which was available through the Corps-wide CADD contract with Intergraph Corporation, is commonly available and used in USACE offices. However, numerous other CADD packages that run on PC-based computers, such as AutoCAD™, GWN-COGO™, and TRU-CAD™ are available.

6-6. Total Station Data Collection and Input to CADD

Survey data can be entered into a CADD program by a variety of methods. The most favorable means is through digital data files produced by electronic survey equipment. Total stations, GPS survey receivers, and some electronic levels are commonly capable of recording survey data on electronic data collectors, floppy disks, cassette tapes, magnetic cards, internal media, or interfaced field computers. Such logging of data greatly increases the efficiency and accuracy of data collection, and eliminates human error associated with field book recording. These digital data files also eliminate the tedious and error-prone manual entry of data into CADD programs. It should be noted that automatic data logging clearly offers a superior method for recording and processing survey angles, ranges, or coordinates, but does not eliminate the field book. Survey conditions, description of the project, unplanned procedures, and other pertinent information must always be recorded by field personnel to establish complete survey records.

a. For total station instruments, various software/hardware packages are available to collect and process survey data. For example, survey adjustment packages such as Wildsoft™, Pacsoft™, and SDRMAP™, which are PC-based, will interface to a variety of data collectors. Some collectors are actually PC-based processors that can log total station data and run various survey adjustment software packages. Intergraph's Electronic Theodolite Interface™ offers a full set of hardware and software to log survey data, perform post-processing and adjustments, and import the data into an Intergraph workstation for CADD processing.

b. If procuring components of a data collection and processing system, compatibility between components and a minimum capability must be assured. Survey coordinates with a descriptor or code to indicate the surveyed feature should be input, as a minimum, to the CADD system. ASCII X-Y-Z or latitude-longitude-height data, along with alpha-numeric descriptor data, are usually accepted by CADD software and are commonly output by data collectors or survey processing programs. The CADD program should have some flexibility in the order the coordinates are received (i.e., X-Y-Z, Z-X-Y, etc.) and the length of the data records.

c. More complex and sophisticated information, such as contour lines and symbols, can sometimes be passed from survey to CADD programs through common graphic formats, such as DXF. However, note that a 100% reliable transfer of graphic data is not always possible. For example, contour lines passed to a CADD program in DXF format may have isolated breaks or overlap. Transfer of graphic data using proprietary formats is usually most reliable.

6-7. CADD Plotting

a. CADD systems offer extreme flexibility in data plotting, and can normally follow the specification described in the previous section. Sheet sizes available are dependent on the plotter or printer. "A" size is usually available on all output devices, and in most cases a desktop printer will suffice. Some desktop devices are capable of "B" and "C" sizes, and standing floor-mounted plotters are usually required for "D" and "E" sizes. Pen plotters can output on most desired media, including paper and mylar.

b. Plotters that use mechanically guided pens are the most common, and usually inexpensive, plotting device. With the proper pen cartridges, the quality of plots is equal to or greater than that of professionally drafted manual plots. Note that these devices produce only line segments or curved lines. Thus, a shape that is color-filled would be produced through numerous color strokes. Such tedious plots require long plotting times, and produce more wear on the pens and the plotter itself.

c. Plotters that use electrostatic, ink jet, thermal, or laser techniques are becoming more common. Such devices produce excellent quality plots and are much

quicker than pen plotters. However, these devices are considerably more expensive and may output only on specific media.